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THE 1988-89 PASSCAL BASIN AND RANGE PASSIVE-SOURCE SEISMIC EXPERIMENT

PART II: Small Aperture Array Data

Prepared by
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for the
Project Science Team

PASSCAL Data Report 90-002

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Data Report

for

The 1988-89 PASSCAL Basin and Range

Passive-Source Seismic Experiment

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***** PASSCAL DATA REPORT #90-002 *****

ABSTRACT

This report describes the data from the 1988-89 PASSCAL Basin and Range Passive Source Seismic Experiment, collected by the small aperture array consisting of 13 REFTEK digital recorders with 12 3-component 1 Hz seismometers and one 3-component intermediate period seismometer. A total of 53 seismic events with known locations, and many smaller local events without locations are included in this data distribution. Data formats, auxiliary information, calibration information, and organization of the distribution data tape are discussed.

1. Introduction

The 1988-89 PASSCAL Basin and Range Passive Source Seismic Experiment consisted of two deployments. The Large Aperture Array of 7 PASSCAL data recorders was deployed from August 17, 1988 until April 29, 1989. The Large Aperture Array used 3-component mid-period sensors, and each site operated independently in a triggered mode. A Small Aperture Array, consisting of the Lawrence Livermore National Laboratory (LLNL) Configurable Seismic Monitoring System (CSMS), was deployed from August 1988 through October 1988. The Small Aperture Array used primarily 3-component short-period sensors, and operated in a continuous recording mode with digital telemetry to a central recording site.

The study area was in the region of the Stillwater Range in Nevada (see Figures 1 and 2), and was chosen to coincide with the center of the crossing refraction profiles of the 1986 PASSCAL Basin and Range Lithospheric Experiment. This location was chosen so that a comparison of lithospheric modeling techniques, principally receiver function modeling, and refraction and reflection modeling, could be compared in a coincident study area.

The experiment team consisted of a field crew, and project scientists. The field crew, Randy Kuehnel and Thom Morin, deserve a great deal of credit for the success of the field operation. Their consistent dedication and effort made both array deployments operate as smoothly as possible, and aided greatly in the preliminary data processing. The project scientists consisted of T.J. Owens, D. McNamara (University of Missouri, now at University of South Carolina), G.E. Randall, K.F. Priestley (both at University of Nevada-Reno), and G. Zandt (at the LLNL Institute for Geophysics and Planetary Physics).

The instrumentation for the Small Aperture Array consisted of the LLNL CSMS system, with 13 continuously recorded digitally telemetered stations. The short-term, small-aperture array consisted of four three-station sub-arrays located about a central recording site. This central site was co-located with a station from the large aperture array (FNC)(Figure 2), and operated with mid-period (Kinemetrics SV-1 and SH-1) seismometers. The remaining 12 stations used short period (Geotech S-13) 3-component seismometers. Time information was derived from an OMEGA clock at the central recording site, and rebroadcast to synchronize the field sites. The field sites used digital telemetry via radio links to pass the 100 sample per second data to the central recording site, where data was continuously recorded onto either optical disk or 8 mm tape for later demultiplexing and analysis.

The Small-Aperture Array was centered on the Large-Aperture Arrays FNC site (Figure 2; Table 1) and was located on the eastern side of the Buena Vista Valley on a westward dipping alluvial fan of Quaternary age. This deposit is characterized by poorly sorted, unconsolidated sands, silts and gravels derived from the adjacent Stillwater Range. Bedrock was estimated to be at a depth of no less than 30 meters (Johnson, 1977).

This data report summarizes the data available from the Small Aperture Array. The Large Aperture Array has been previously described in Part I of this report. A complete Large Aperture Array data report and digital data is available from the IRIS Data Management Center in PASSCAL Data Report #90-001 (Owens and Randall, 1990). The standard distribution tape for this experiment is trace data for located seismic events. Supplementary raw data for unlocated events is also available to interested researchers.

2. Description of Data Distribution

The Small-Aperture Array data has been provided to IRIS in one set which is a tar file of a UNIX file structure. The contents of distribution is described below. The entire data distribution totals just over 277 Mbytes in size.

All of the trace data in this data distribution is in SAC format. SAC is an acronym for "Seismic Analysis Code", a general purpose software package for the manipulation of seismic data developed at Lawrence Livermore National Laboratory (LLNL). It is available through IRIS or LLNL. We primarily used trigger times from the LAA and the Quick Determination of Epicenters (QDE) listings obtained through the toll-free modem number of the National Earthquake Information Center (NEIC) to determine appropriate time windows for the SAA. Local and regional events not found in the QDEs were often found in the Nevada Regional Catalog distributed by the Seismological Laboratory of the University of Nevada-Reno. Time windows ranging from three to fifteen minutes, depending on the nature of the event, were read from the 8 mm tapes. Due to hardware imcompatibilities, data recorded on optical disk early in the experiment were never recovered.

We were able to identify most seismic events using this method, however many smaller local events or mine blasts could not be assigned a location from either catalog. These were retained and are distributed as the "Raw Data Distribution" described below. All events with known locations were assigned an event number and trace data from these events make up the primary data distribution. This data is termed the "Numbered Event Data" and is described in the next section.

2.1. Numbered Event Data

A total of 47 separate seismic events with known locations make up the numbered event data. We used the same event numbers used by Owens and Randall in Part I of this report. Two events (215 and 216) were added to the master event list. These events are listed in chronological order in Table 2. Our numbering scheme for the LAA was as follows:

001-299	P-wave triggers
701-999	Teleseismic S-wave Triggers
301-599	Other Teleseismic Body Wave Triggers

In the cases of an S-wave trigger, the event number assigned was the P-wave trigger number plus 700 and for the other teleseismic triggers, the event numbers assigned were the P-wave trigger number plus 300. For example the Tonga Islands event of 10/08/88 triggered some sites on the P-wave, and S-wave. These were assigned event numbers 053, 753 respectively. For the SAA teleseismic data, we were able to extract both P-wave and S-wave windows for several events and we followed the same numbering scheme for these events. For the SAA data, we attempted to extract sufficiently long windows to include all useful phases for local and regional events.

The numbered event trace data is distributed using the following file naming convention:

EVT.saa/STA.C

Where *EVT* is the assigned event number, column 1 in Table 2; *STA* is the station name, column 1 in Table 1; *C* is the component identifier, *z* for Vertical component (positive up), *n* for North component (positive north), or *e* for East component (positive east).

The trace data amplitudes are given in units of volts. The event and station latitude, longitude, and depth or elevation as well as the proper component orientations have been entered into the proper SAC header fields. The numbered event data distribution is organized in the following UNIX directory structure:

Directory Name	Size (Mb)	Description of Contents
NV88_SAA/	277.1	Main Directory
./calb	19.2	Calibration Traces
./tele	100.8	Teleseismic events
./others	61.6	Local and Regional Events
./tele.std	49.5	Standardized teleseismic data
./unlocated	42.2	Unlocated trace data
./data_report	3.8	text and figures of this report

2.1.1. Teleseismic Data

A typical event recorded by the Small Aperture Array is plotted in Figure 3. The NV88_SAA/tele.std directory contains the teleseismic traces standardized to a sampling rate of 100 samples/sec and a record length of 210 sec. In tele.std, the mean of each trace has been removed and a Hanning taper applied to the first and last 7.5 sec of each trace. Also, for each event, the traces at all stations recording the event have been synchronized to a common reference time to allow for more accurate array analysis. Some low signal-to-noise ratio traces and events with other quality control problems have been discarded from this directory. This directory contains the data used in the research portion of this study. The NV88_SAA/tele directory contains teleseismic events saved at their original record length without the processing described above.

2.1.2. Local/Regional Data

The NV88_SAA/others directory contains all of the trace data for non-teleseismic events recorded by the Small-Aperture Array. Figures 4 and 5 show typical regional and local events. Each trace has the original sampling rate and record length. Since we have not used this data in our research to date, we have not made thorough attempts to cull low signal-to-noise ratio events or other events with data quality problems from this data set.

2.2. Calibration and Quality Control

The Geotech S-13 seismometers are moving-coil electromagnetic sensors with an nominal free period of 1 Hz. The Kinemetrics SV-1/SH-1 sensors are moving-coil electromagnetic seismometers with a nominal natural period of 5 seconds. Damping resistors were added to the seismometer circuit to obtain a nominal damping of 0.7 critical. The data streams were filtered by the local REFTEK 97 digitizer with a 6-pole Butterworth lowpass anti-aliasing filter with a corner at 22.5 Hz and an analog 1-pole high pass filter with a corner at 1 Hz. The high pass filter could be selected or omitted by digital commands from the CSMS central recording trailer, but was routinely applied during this experiment. A calibration procedure could be activated simultaneously at all sensors from the central recording trailer. This involved digital commands to activate the calibration coils and inject current steps into them periodically. This was done 9 times during the deployment. Each calibration is contained in a separate subdirectory of the NV88_SAA/calb directory in our data distribution. The subdirectories are named with the Julian day and time at which the calibration was executed with the suffix .c appended to indicate a calibration event.

We have not included estimated system responses for each calibration with this data distribution. The 0.1 Hz high pass filter has been extremely difficult to model accurately using our existing codes which perform time domain iterative least squares fits of the calibration pulses (as described in Part I of this report). This prevents us from getting an accurate estimate of the free period and damping for the 1 Hz seismometers at the present time.

The telemetry process occasionally introduced spikes into the recorded data streams. In addition if the CSMS software detected corrupt time stamps, then a spike with a value of 32768 counts was put in the data stream to flag the potential problem. This latter type of spike is often associated with a visible tear in the continuity of the data. Since individual applications will determine the significance of these data quality problems as well as the most appropriate method of removing or avoiding these glitches, we have not attempted to remove them from the data distributed here. We have found that the "rglitch" command in SAC is effective in removing single spikes of the type that can occur in this data set.

3. Raw Data Distribution

Since events for which no catalogued location exists may still be of interest to other researchers, we have included them with our data distribution in a directory called NV88_SAA/unlocated. In this directory, individual events are in subdirectories named by the Julian day and time of the start of the data window.

4. Data Report Format

We have included in the directory NV88_SAA/data_report a complete version of the text in UNIX troff format and the figures in PostScript format. On our Sun Microsystems workstations, the data report may be printed using:

eqn nv88_saa.txt | tbl | ptroff -ms

The Figures may be printed on a PostScript printer using:

lpr figure*.ps

5. Acknowledgements

The CSMS equipment was provided by LLNL through internal funding to George Zandt of LLNL-IGPP. Sally Owens carefully read the data from the 8 mm field tapes and did initial event identification and quality control work. Technical, logistical and administrative assistance by Brenda Bowman, Diane DePolo, Dan Ewert, Craig Johnston, Wally Nicks, Sally Owens, Don Rock, and Jay Zucca was valuable. This project was supported by IRIS grants to the University of Missouri-Columbia, the University of South Carolina, and the University of Nevada-Reno. T.J. Owens was also supported by the UMC Research Council during the Fall of 1988.

6. References

Johnson, M., Geology and mineral deposits of Pershing County, Nevada, Bulletin 89, Nev. Bur. Mines & Geology, 1977.

7. Data Distribution

The Data referenced in this report may be obtained through:

IRIS Data Management Center
8701 Mopac Blvd., Suite 205
Austin, TX 78759
Telephone: (512) 471-0403, 0404, or 0405

TABLE 1

Small Aperture Array
Station Locations

Station Name	Latitude (Deg. N)	Longitude (Deg. W)	Elevation (meters)
ctr	40.096	117.885	1487
a1	40.087	117.868	1585
a2	40.082	117.830	2085
a3	40.073	117.851	1762
b1	40.088	117.934	1387
b2	40.087	117.906	1466
b3	40.065	117.908	1597
c1	40.119	117.914	1341
c2	40.125	117.887	1402
c3	40.106	117.897	1414
d1	40.075	117.995	1439
d2	40.133	117.974	1242
d3	40.160	117.932	1414

TABLE 2

Event Locations

Evt ID	Date	Origin Time	Latitude (Deg)	Longitude (Deg)	Depth (Km)	Mb	Region
001	08/17/88	015911.1	7.658S	107.264E	58	6.0	JAVA.
007	08/17/88	170000.0	37.297N	116.307W	0	5.4	SOUTHERN NEVADA. "KEARSARGE"
008	08/26/88	215323.1	38.810N	118.069W	20		Near Lovelock, NV
009	08/27/88	012517.7	11.303N	141.455E	33	5.2	WEST CAROLINE ISLANDS
215	08 27 88	020530.6	39.530N	118.470W	13	2.4	Nevada Local
010	08/27/88	163017.6	15.838S	172.144W	33	6.0	SAMOA ISLANDS REGION
216	08 30 88	023033.4	37.890N	116.081W	0.05	3.3	Nevada Local
011	08/30/88	122824.9	37.540N	118.353W	5		CALIFORNIA-NEVADA BORDER REGION.
012	08/30/88	180000.1	37.086N	116.069W	0	5.0	SOUTHERN NEVADA. "BULLFROG"
013	08/30/88	190345.0	37.086N	116.069W	0		BULLFROG COLLAPSE? OT/Location estimated
014	08/31/88	164516.0	31.789N	115.796W	5	4.9	BAJA CALIFORNIA. ML 5.1 (PAS).
015	09/01/88	165252.3	17.065N	99.265W	33	5.0	GUERRERO, MEXICO
016	09/02/88	102748.5	54.030N	161.491E	47	5.1	NEAR EAST COAST OF KAMCHATKA
017	09/05/88	061318.7	18.532N	70.391W	33	5.5	DOMINICAN REPUBLIC REGION.
018	09/07/88	115325.4	30.336N	137.364E	499	6.0	SOUTH OF HONSHU, JAPAN
718	09/07/88	115325.4	30.336N	137.364E	499	6.0	SOUTH OF HONSHU, JAPAN *** S-WAVE
019	09/13/88	005845.9	29.806N	138.364E	447	5.8	SOUTH OF HONSHU, JAPAN
020	09/14/88	035957.4	49.801N	78.791E	0	6.1	EASTERN KAZAKH SSR
021	09/14/88	221407.6	23.387S	67.945W	124	5.8	CHILE-ARGENTINA BORDER REGION
022	09/15/88	184803.2	1.404S	77.896W	189	5.8	ECUADOR.
722	09/15/88	184803.2	1.404S	77.896W	189	5.8	ECUADOR. *** S-wave
023	09/16/88	000652.9	22.952S	175.413W	33	4.9	TONGA ISLANDS REGION
024	09/16/88	021614.9	20.362S	178.364W	500	5.2	FIJI ISLANDS REGION
025	09/16/88	024535.8	20.170S	.177.770W	500	4.7	FIJI ISLANDS REGION
026	09/16/88	062729.0	17.785S	169.065E	33	4.9	VANUATU ISLANDS
027	09/17/88	062014.6	29.900N	114.100W	10	4.4	BAJA, CA from NEIC via phone
028	09/17/88	152353.7	44.910N	152.945E	43	5.3	KURIL ISLANDS REGION
029	09/19/88	025630.7	38.432N	118.320W	5	4.5	CALIFORNIA-NEVADA BORDER REGION.
030	09/19/88	032215.8	38.461N	118.341W	5		CALIFORNIA-NEVADA BORDER REGION.
032	09/19/88	185837.7	23.003S	175.508W	33	5.4	TONGA ISLANDS REGION
033	09/19/88	210145.8	38.478N	118.111W	5		CALIFORNIA-NEVADA BORDER REGION.
034	09/20/88	001609.1	38.937N	118.063W	5		CALIFORNIA-NEVADA BORDER REGION.
035	09/21/88	095851.8	46.129N	152.142E	38	5.9	KURIL ISLANDS
042	09/26/88	082321.4	35.402N	140.864E	45	5.9	NEAR E COAST OF HONSHU, JAPAN
045	09/30/88	003014.8	41.535N	121.627W	5		NORTHERN CALIFORNIA. ML 4.1
046	09/30/88	004004.4	41.534N	121.598W	5		NORTHERN CALIFORNIA
047	09/30/88	214501.1	19.356S	177.555W	548	5.4	FIJI ISLANDS REGION
747	09/30/88	214501.1	19.356S	177.555W	548	5.4	FIJI ISLANDS REGION *** S-WAVE
048	10/01/88	094324.5	35.305S	106.059W	10	5.6	EASTER ISLAND CORDILLERA
049	10/02/88	160930.0	27.100N	110.100W	10	4.7	GULF OF CALIFORNIA from NEIC via phone
050	10/03/88	004557.8	10.227S	161.243E	130	5.5	SOLOMON ISLANDS
051	10/04/88	003410.7	41.420N	121.593W	5		NORTHERN CALIFORNIA. ML 3.2
053	10/08/88	044624.4	18.693S	172.429W	33	6.7	TONGA ISLANDS REGION
753	10/08/88	044624.4	18.693S	172.429W	33	6.7	TONGA ISLANDS REGION *** S-WAVE
054	10/08/88	211420.1	36.098N	117.860W	6		CALIFORNIA-NEVADA BORDER REGION.
055	10/08/88	212606.3	36.098N	117.860W	6		CALIFORNIA-NEVADA BORDER REGION.
058	10/10/88	071921.2	23.161S	171.969E	33	5.6	LOYALTY ISLANDS REGION

059	10/10/88	182030.0	28.344S	177.670W	57	6.5	KERMADEC ISLANDS REGION
759	10/10/88	182030.0	28.344S	177.670W	57	6.5	KERMADEC ISLANDS REGION *** S-WAVE
060	10/11/88	133005.1	40.279N	125.632W	10	3.6	OFF COAST OF NORTHERN CALIFORNIA
061	10/13/88	140000.0	37.089N	116.049W	0	5.9	SOUTHERN NEVADA. *** "DALHART"
062	10/13/88	161807.8	37.089N	116.049W	0	4.3	SOUTHERN NEVADA. *** "DALHART COLLAPSE"

8. Figure Captions

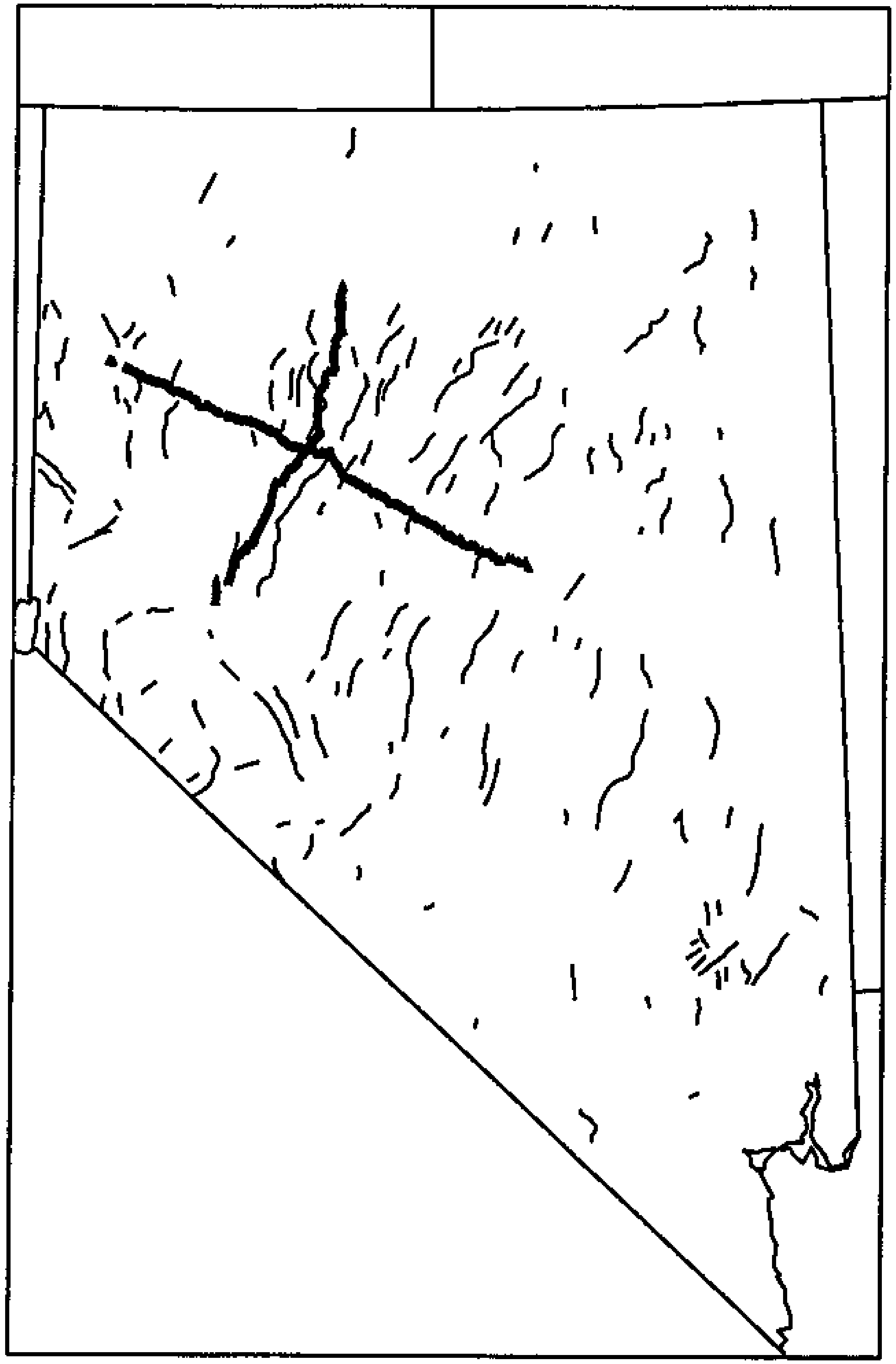
Figure 1. Basemap of Nevada. Heavy lines show the locations of the 1986 PASSCAL Basin and Range Active-Source Seismic Experiment. The 1988-89 Passive-Source Experiment was located in an area with a radius of 20 km around the intersection of the 1986 lines.

Figure 2. Expanded map of stations locations. Boxes are the stations of the Large Aperture Array, diamonds are the stations of the Small Aperture Array, and small triangles are the sites of the 1986 Active Source Experiment.

Figure 3. P-wave trigger for Event 024 recorded by the Small Aperture Array.

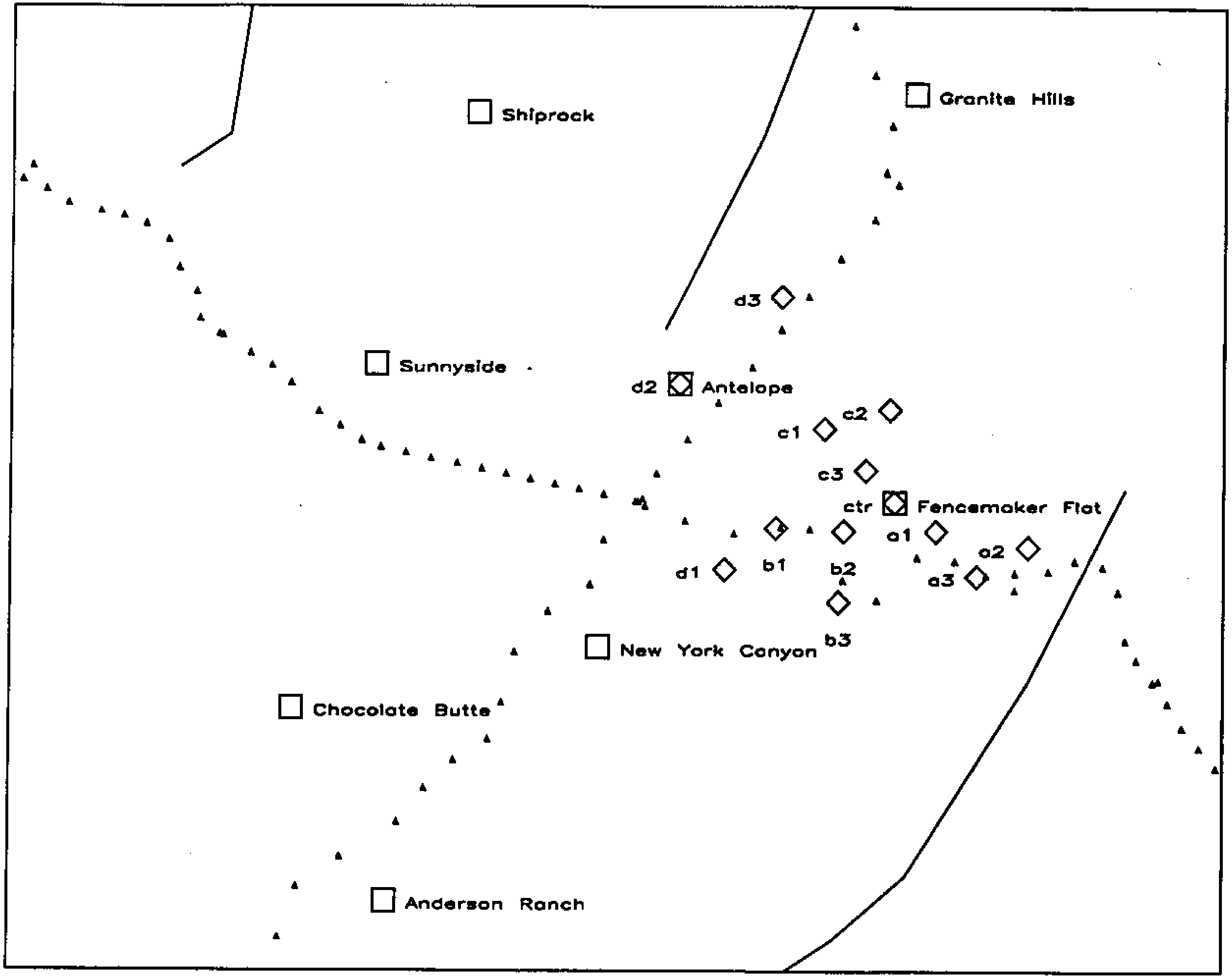
Figure 4. Trigger for Event 011, regional event from the California-Nevada border region, recorded by the Large Aperture Array. Station d3, bottom trace, was known to have some timing problems.

Figure 5. Trigger for Event 215, a local Nevada event, recorded by the Large Aperture Array.



PROJECTION ORTHOGRA; POLE 40.00 −118.00 0.00
WINDOW CORNERS 35.0000 −120.0000 42.5000 −113.5000

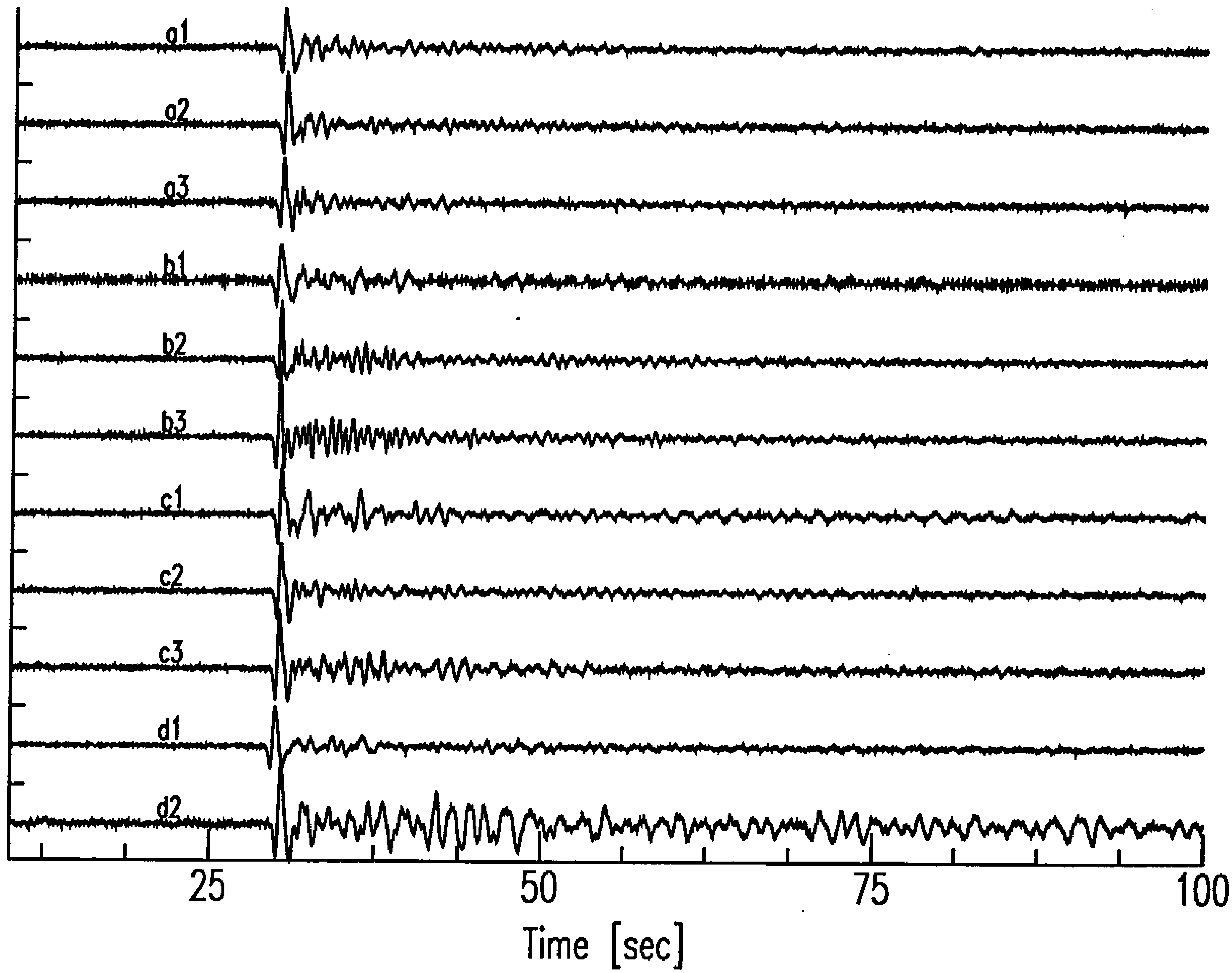
Owens and McNamara, PDR 90-002, Figure 1



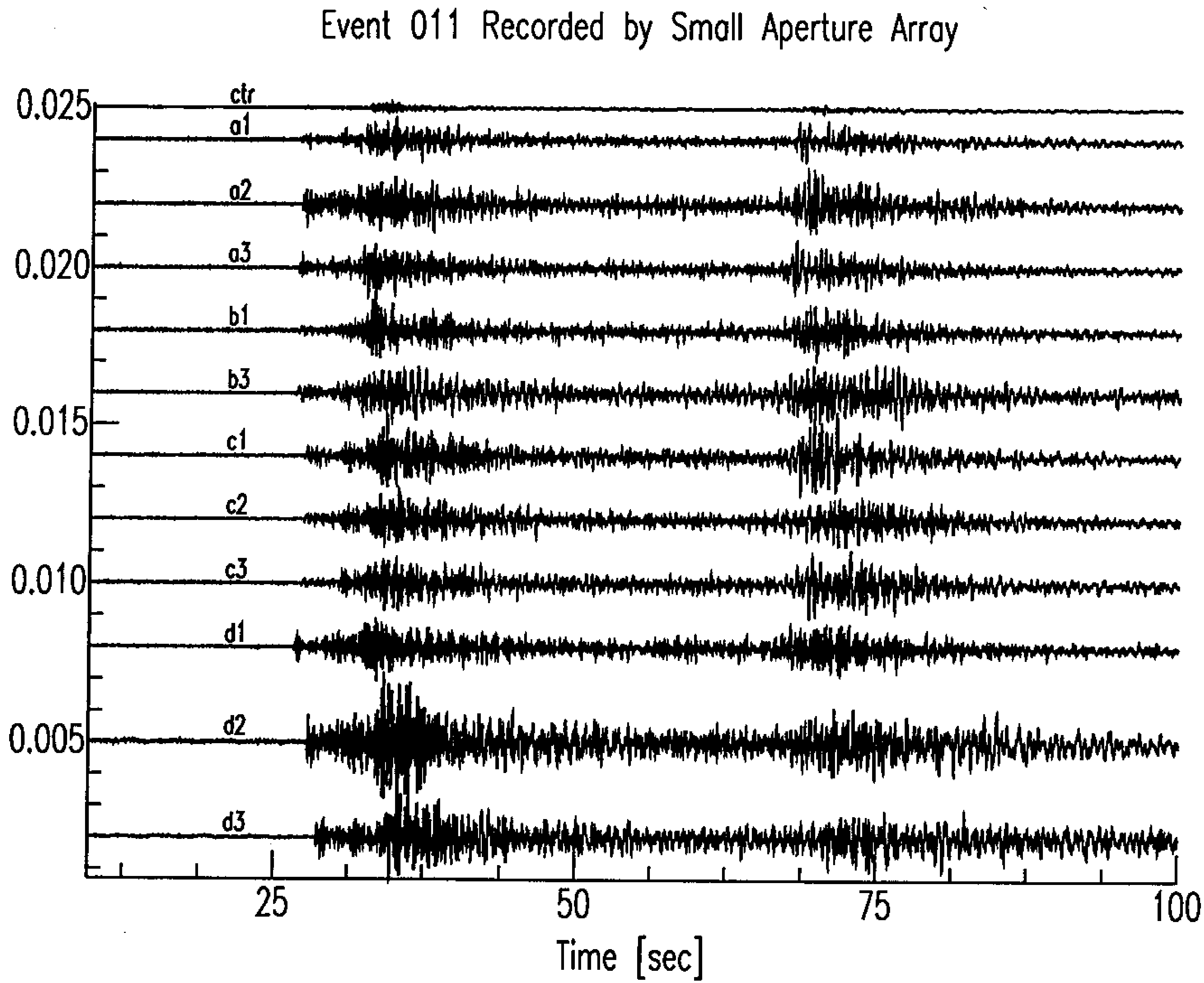
PROJECTION ORTHOGRA; POLE 40.00 −118.00 0.00
WINDOW CORNERS 40.2500 −118.2500 39.9500 −117.7500

Owens and McNamara, PDR 90-002, Figure 2

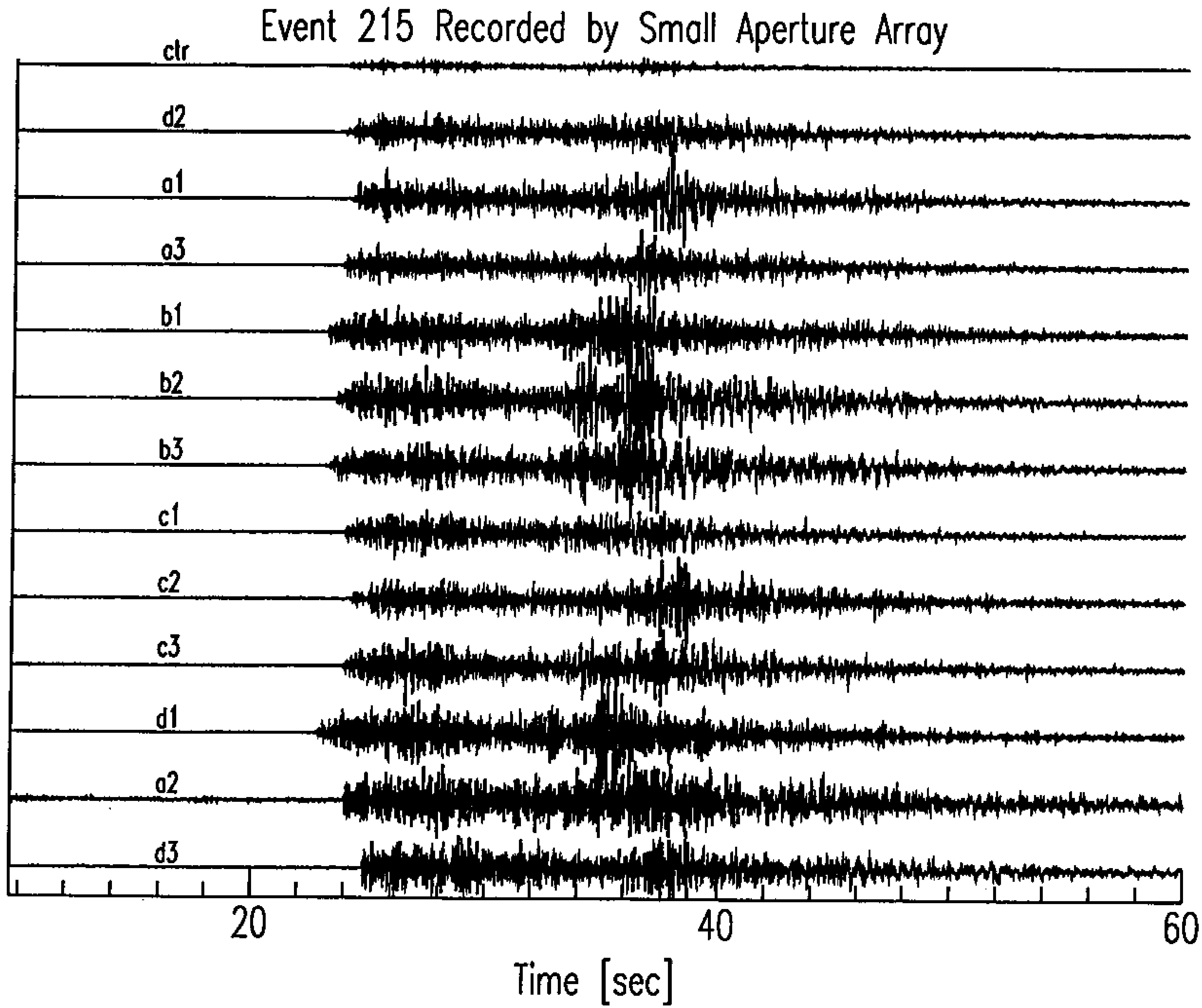
Event 024 Recorded by Small Aperture Array



Owens and McNamara, PDR 90-002, Figure 3



Owens and McNamara, PDR 90-002, Figure 4


Event 215 Recorded by Small Aperture Array
ctr
d2
a1
a3
b1
b2
b3
c1
c2
c3
d1
a2
d3
20
40
60
Time [sec]